GAS HEAT (AP) in INDUSTRY

10/6 Per Annum — Formerly INDUSTRIAL GAS TIMES — APRIL, 1950

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GAS HEAT *in* INDUSTRY

Vol. XIII April, 1950 No. 151

A Gas Burner for Heating Solution Tanks

GAS as a source of tank heating in electroplating, pretreatment, pickling, rinsing, etc., is a very convenient fuel. Furthermore, with the efficient burner now to be described, it is possible for the factory to install its tank heating services both simply and economically.

The principle of combustion behind Duoflam burners, made by Radiant Heating Ltd., Barnsbury Park, London, N.1, is the introduction of secondary air above the gas orifice in the jet tubes. As the primary mixture leaves each pair of jets the partial vacuum created draws into the flame the additional air needed to give efficient combustion.

The burners develop a very high flame temperature with town gas at pressures as low as 15 to 20 tenths, so that heat can be intensified in confined spaces without the use of fans, boosters or other means of added pressure. They need no adjustment and can be turned down to 95 per cent. of maximum gas flow in absolute safety. Thus they are well adapted for thermostatic control.

Duoflam burners are supplied with special jets adapted to the calorific value of the gas in the area in which they are to be used, so that they produce a Bunsen flame of high pressure effect using low pressure town gas.

Advantages

Among the advantages claimed are the absence of an adjustable injector and a high flame temperature, whilst burner units can be built to any size. The gas orifice, air port and tube sizes in each range of jets are designed to prevent the burners from lighting back, and they burn almost silently.

The standard burner units are made in a variety of shapes and sizes so that outfits can be built from stock to suit any proposed installation.

However, the Duoflam burners are not recommended for high tempera-

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ture metal melting or heat treatment operations, nor for the conversion of Cornish, Lancashire or other types of boilers having long horizontal tubular fireboxes. Furthermore they should not be used if combustion space is limited, particularly in height. It is most important that flames from each pair of impingeing jets should merge fully and not be checked by contact with any solid body, otherwise carbon will be deposited and carbon monoxide will be present in the flue products.

Also, it is not advisable to fit Duoflam burners under a pan or other vessel without enclosing them in a combustion chamber.

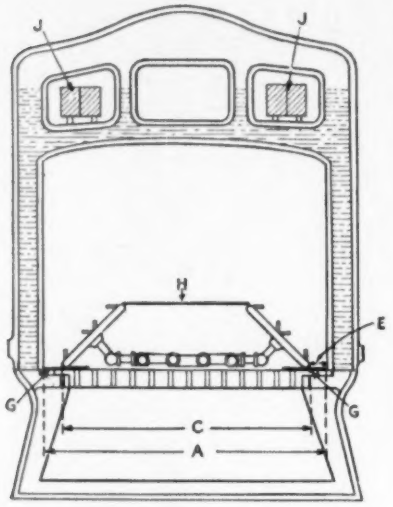
Typical applications of the burners are in sectional and vertical steam and hot water boilers, electroplating, phosphating, rinsing, pretreatment, pickling tanks, as well as varnish kettles or wherever an open gas flame is suitable. They are also suitable for fish frying ranges, sugar boilers, air heaters, blacking and similar ovens and stoves, sterilizers, bakers' ovens, lead and other low temperature melting pots, rinsing and degreasing vats, milk boilers, double oven ranges for canteens and feeding centres, etc.

The brass jets of the burners need cleaning periodically by removal, using a special jet wrench and boiling thoroughly in ordinary domestic vinegar. They are then drained and replaced when dry.

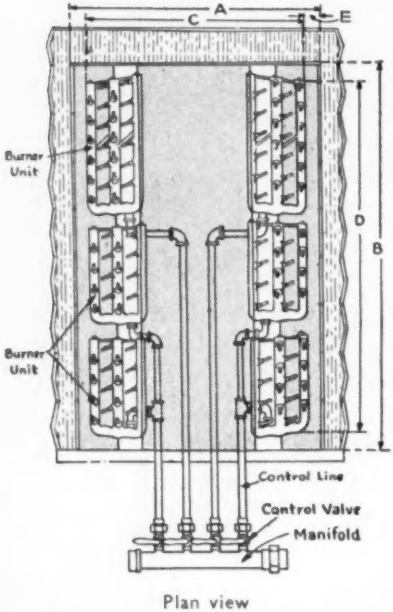
Brass jets should not be used for high temperature work or when the burners are placed in proximity to brickwork or refractories. Then special aluminium-bronze or stainless steel jets are used.

When used for under-firing metal pots or tanks, the tips of the burner jets should be approximately 8 in. below the bottom of the pot.

Duoflam burners have all the advantages of luminous flame burners, but because they are Bunsen burners they are free from the drawback of carbon deposit and burn with correspondingly higher flame temperature.



Sectional elevation



Plan view

A. Width of firebox at grate level.

B. Length of firebox at grate level.

C. Width of burner assembly.

D. Length of burner assembly.

E. Clearance (1 in.) from burner layout to side walls of firebox.

G. Lower baffle.

H. Upper baffle.

J. Baffling in flue ways in sectional boiler.

Results of Orsat Tests

The following figures are an average selection of results of Orsat tests taken by various gas undertakings and others on boilers which have been converted to gas firing by means of Duoflam burners:—

Boiler.	*% Heat loss in flue*
Beeston Robin Hood 8CN ...	20·04
Ideal Classic No. 3	20·07
Ideal Britannia 35K	21·40
Crane Whitehall 26	18·26
Beeston Robin Hood 5CN ...	23·00
Hartley and Sugden White Rose 38	20·13
Ideal Britannia 25K	21·20
Beeston Robin Hood 7F ...	17·70
Ideal Neo-Classic NC72 ...	22·04
Beeston Robin Hood 9C ...	18·00
Lumby Solar B17	21·02
Beeston Robin Hood 12C ...	20·00
Wagstaff Low Eclipse 85 ...	20·22
Beeston Robin Hood 9H ...	23·00
Hartley and Sugden Vertical Multitubular (Steam) No. 7	25·10
Lumby Vertical Cross Tube (Steam) 4 N.H.P.	29·35

Application

A large number of both direct and indirect air heaters have been fitted with Duoflam burners. In the case of a direct heater care must be taken to see that the fan sets up no direct pull on the burners, which calls for attention to baffling, shrouding and breaking of the pull. The actual methods to adopt will depend on the design of the heater. Autoclaves can often be successfully fired using the burners.

Duoflam burners have long been used extensively for melting lead. They are not recommended for refining processes where high temperatures are required, but for bringing lead up to ordinary pouring temperature they are exceedingly efficient. For the ordinary lead pot it is suggested that a heat input of 125 B.Th.U. per lb. of lead be provided, and that the burners be placed under the pot with a clearance of 8 in. minimum between the tips of the jets and the bottom of the pot.

The application to stereo metal melting is very similar to that of lead melting but it is recommended that 185 B.Th.U. per lb. of metal be allowed in fixing the gas capacity of the appliance. Many of the leading makers of hospital sterilizers and stills use the burners for their gas heated units.

When applying Duoflam burners to tanks containing aqueous solutions it is necessary from the point of view of efficiency, that an enclosed combustion chamber be constructed underneath the tank. If the hot products of combustion are circulated round the tank by means of an additional casing, with a baffled flue outlet at the top, so much the better. For small tanks a clearance of 6 in. between the tips of the burner jets and the bottom of the tank will be sufficient, but this dimension must be increased as the burner outfit gets larger so as to allow of sufficient combustion space to clear the spent products from above the burners at a rate which will allow for the maintenance of good combustion.

In the application of gas firing to any tanks it is best to consider the burner installation during the design stages and before constructional work has commenced.

TABLE OF GAS CAPACITIES

Calorific Value of Gas	*Cubic ft. of gas per hour*	
	Boilers up to	*Boilers* 25,000
B.Th.U.	25,000	*to* 50,000
per c. ft.	*B.Th.U.*	*B.Th.U.*
400	88	175
425	83	165
450	78	156
460	76	152
470	75	149
475	74	148
480	73	146
500	70	140
515	68	136
530	66	132

B.I.F. Space Change.—With regard to the British Industries Fair gas section, we are informed that Hind-Griffiths Furnaces Ltd., space No. D.345, have withdrawn from the exhibition and this space will be occupied by Cochran and Co., Annan Ltd., moving from space No. D.349.

Painting of Structural Steelwork.—We have received a copy of the Second Interim Report of the Corrosion Committee—Protective Coatings Sub-Committee—of the British Iron and Steel Research Association.

Gas Facilitates Rug and Carpet Cleaning

WHATEVER the ramifications peculiar to a processing of any business operation, if heat is required, gas as a fuel will nearly always be found to be fittingly applicable. For example, in rug and carpet cleaning, which some may consider to be a prosaic type of business, an American concern has found that the use of a special gas-fired oven speeds production and contributes to good workmanship.

The Company has in operation such a gas-fired oven. For more than 50 years this organisation has enjoyed an enviable reputation throughout the territory it serves, in rendering a complete service for the cleaning of floor coverings. The company is one of the principal rug and carpet cleaners in the area, doing a retail business exclusively.

Variety of Materials

A rug and carpet cleaner has to cope with a variety of materials—wool and worsted, linen and cotton, jute and silk—put together in a variety of weaves. Each has its various shrinkage characteristics, strength of fabric, susceptibility to loss of colour, and other qualities which enter into consideration in the cleaning process.

There are the Brussels, presenting a ribbed surface of loops; the Wiltons, in which these loops are slit, resulting in a tufted surface; the Orientals, in which the tufts are inserted and knotted down by hand; the Axminsters, in which the tufts are inserted by machine and bound down without knotting. These and other makes have each their own special characteristics which the cleaner must consider.

He must also know the effect of the various detergents upon fibre and colour. This requires a knowledge of the chemical action of dry-cleaning solutions, a great variety of soaps, and a long list of special solvents for the removal of the various stains caused by various materials.

Gas fuel has opportunity to play a part in the various operations involved. The production line incorporates the following sequence of operations: the rugs, following skilled inspection, go to the dusting machine, a mechanical duster which produces about a ton of dirt from each 1,000 rugs; then to the washing machine, a rotary drum affair, which requires considerable volumes of water; then to the rinsing machine where the rugs are thoroughly rinsed; and then to the wringer. From there the rugs go to a conveyor drying room where drying is accomplished by circulated warm air heated by steam coils. Here is an opportunity for the use of gas in the firing of a steam generator, or direct air heating.

From the drying room on, gas plays a major *rôle* in the finishing of the rug cleaning operation. The rugs are taken to the finishing oven room and are placed, bottom up, on a steel frame, which stretches them to their original dimensions. The washing process has not only taken out the dirt but it has also removed the original sizing or "body" of the rug. This sizing must be restored.

An expert operator sprays upon the back of the stretched rug exactly the correct amount and type of sizing. This is one of the more critical of the various operations in the cleaning process. It is only through long experience that the rug finisher knows the exact amount of sizing that each type of rug should receive. When the spraying operation is completed the rug on its steel frame is pushed into the oven.

Details of Oven

The oven is 10 ft. wide, 15 ft. long, and 6 ft. high. It has four horizontal compartments, each of which may receive one steel frame and its rug.

The heating equipment consists of a gas-fired recirculating air heater placed external to the oven. Burner rating is 250 c. ft. of 1,000 B.Th.U. natural gas

per hour. Temperature is automatically controlled, with a maximum temperature of 250° F. The burner equipment is fully equipped with safety protective devices. The operator needs only to set the automatic control for the temperature desired. Experience shows that the products of combustion mixed with air and used for direct heating, are not injurious to rugs or carpets. The normal drying cycle is 25 minutes.

Rugs and carpet pieces up to 12 ft. by 15 ft., which constitute 75 per cent. of the business of the plant, are finished in this oven. Staffed by two men, the oven will handle 10 rugs per hour. When the rugs come from the oven they are in the same condition as to texture and body, as when new.

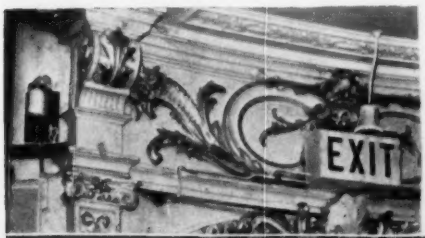
Gas Lighting in King's Theatre Hammersmith

THE need to ensure public safety has led to very stringent regulations about the lighting of large public halls and places of entertainment. It is a statutory requirement that there should be a secondary lighting system to ensure safety in the event of a failure of the main supply, and many theatres, cinemas, restaurants, schools, etc., make use of gas for this purpose.

The photographs illustrate the installation carried out recently at the King's Theatre, Hammersmith, by the firm of William Edgar and Son Ltd., of Hammersmith, W.6, all the equipment being of their own manufacture. The wall fittings are the B.W.39 type, specially designed for secondary lighting, but also adaptable for domestic use. The burner is a single inverted bijou, with permanent by-pass, and gas and air regulators, and is so constructed that it cannot be tampered with by the public.

The exit boxes are also gas-lit. Both the wall fittings and the exit boxes are lit before the public is admitted, and kept alight throughout the performance. In addition to the auditorium, the lobbies and passages in all parts of the house are equipped with secondary lighting, over fifty separate fittings being installed.

Secondary systems of this type have the approval and recommendations of the London County Council, the Middlesex County Council, and other public authorities. Other public halls which have recently been equipped by this firm include the Cricklewood Dance Hall, the Rivoli Cinema, Ruislip, the Hendon Hall Hotel, the London Palladium, and the Café Anglais Restaurant.



Hot Water Supply

by

NORMAN F. PARRY, A.M.I.H.V.E.

ONLY a complete book about gas-fired appliances for hot water supplies could do justice to the many manufacturers of such products and the industry behind them, and this instalment can but outline the varied equipment available and make mention of only few of the manufacturers by name.

As a fuel for hot water supply systems, gas is very popular, due to its ease of control, its cleanliness and the service so readily available to users of gas-fired appliances. These appliances may be considered under four main headings, as boilers, circulators, storage heaters and instantaneous heaters.

Gas-Fired Boilers

Gas-fired boilers may be used with central storage systems in a similar manner to solid fuel boilers as previously described, or in conjunction with same. There are however one or two applications peculiar to gas boiler systems such as storing water at different temperatures, and the British Standard Code of Practice publication No. CP.332.202 (1948) includes illustrations of such systems in reference to Domestic Hot Water Supply by Gas for Schools.

As with other types of boilers for hot water supply purposes, those for gas-firing may be suitable for either direct or indirect systems depending upon their construction.

Boilers suitable for direct systems have the usual manholes giving access for cleaning purposes, and those for use with soft water have the waterways bower barffed. For combined heating and hot water supply the indirect system is essential.

The rating of a gas-fired boiler is generally limited by the quantity of gas which may be burned in the combustion chamber with a test-bench efficiency of about 80 per cent. Cast-iron sectional boilers specially constructed for gas-firing have combustion efficiencies of 75 per cent. to 80 per cent. under steady load conditions and working efficiencies. Such boilers are manufactured by Potterton Ltd., The Ideal Boiler and Radiator Co. and Lumbys Ltd.

The ratings of cast-iron sectional gas boilers range from 20,000 B.Th.U. per hour to 1,400,000 B.Th.U. per hour, the larger sizes over 200,000 being suitable for indirect systems, generally in conjunction with central heating systems.

Small sectional cast-iron boilers specially designed for gas burning are despatched with sections and jacket assembled whilst the larger boilers of 500,000 B.Th.U. per hour and over are despatched unassembled to facilitate handling.

Some makes of gas boilers are provided with base trays when flat boiler bases are required, but other types are provided with feet and in such cases adequate space must be provided under the boiler for air supply and the foundation should be insulated.

Most solid fuel boilers may be converted for use with gas by fixing a burner such as the "Duoflam" and indeed one boiler manufacturer markets a very successful gas boiler which is but a cast-iron sectional boiler fitted with gas burners and ancillary control equipment. The efficiency of boilers specially designed for gas burning are generally higher than those which are converted for use with this fuel.

On all gas-fired appliances except the flueless types, a flue baffle is necessary to prevent the creation of excessive draught in the apparatus and also obviate the danger due to down draughts. In general the draught created due to the temperature and height of the boiler itself is sufficient to induce the necessary quantity of air for combustion. Some appliances have the baffle or draught diverter as an integral part of the construction whilst

others are supplied with a separate baffle.

Flues from gas boilers are provided to remove the products of combustion and may therefore be made any convenient height provided the area is sufficient to ensure adequate flow of gases. In general, if flues are made the same area as the outlets from appliances it will be found that the draught created per foot of height is sufficient to overcome the frictional resistance per foot run, but where there are an excessive number of bends or trees a larger diameter flue pipe will be required.

Due to the troubles experienced with condensation and the consequent formation of corrosive acids, asbestos cement is favoured for all flues either as a lining to brick flues or independently. It has been found in practice that condensation from flue gases of both gas and efficient solid fuel appliances can have a deleterious effect on cement or mortar joints and parging. Experiments are proceeding at the Building Research Station to investigate the full significance and causes of this trouble.

Gas boilers should be provided with the usual water fittings such as ther-

Architectural students from the South-West Essex Technical College, Walthamstow, are shown the working of a boiling water heater by Mr. P. C. Buckle, who is in charge of the exhibit, during their visit to the Gas Council's "Gas in the Design for Living" section at the Building Centre, Conduit Street, W.1

A large size is also required for tall flues from gas appliances due to the cooling of the gases. Cooling of the flue gases will often result in condensation, and this is especially prevalent during intermittent operation.

Drain cocks should always be provided at low points in gas boiler flues, and when the flue is tall a fan may be used to introduce additional air and so dilute the gases and lower the dew point temperature. Alternatively a second draught diverter or air inlet may be provided and a large diameter flue used as a ventilator.

mometers, safety valves and emptying cocks, and on the larger sizes a pressure gauge is advisable. Gas fittings should comprise gas cocks pressure governor, pilot flame, relay valve with automatic safety cut-out in case of gas failure, and thermostatic control.

Thermostatic control of all gas-fired boilers is essential, and this is most easily achieved by an immersion thermostat operating through a relay valve to regulate the gas supply by the water temperature in the boiler itself. Remote control thermostats may be connected in series with the auxiliary

tube or weep pipe so that the gas supply may be controlled in accordance with the water temperature in the cylinder whilst the boiler thermostat acts as a high limit safety control. The control provided is of the on-off or high-low type, but permanent pilot lights are provided, the connections to which are arranged to by-pass the controls and valves.

Central heating boilers fitted with this form of control may have a room thermostat connected in series, but in such cases the temperature of the water in the boiler will depend on climatic conditions and would be independent of domestic hot water requirements if such were provided by the same boiler. This difficulty is common to all types of boilers burning all types of fuel when the boiler is controlled in accordance with the heating requirements. It is often advisable to provide a separate hot water supply boiler or alternatively operate the heating boiler at a fixed high temperature and control the heating and hot water circuits by means of valves. If the heating system is accelerated an automatic mixing valve may be fitted and arranged to vary the quantity of return water by-passed into the heating flow pipe in accordance with the room temperature or outside temperature.

To prevent the wastage of gas through heat losses during prolonged off-peak periods, a clock control may be incorporated with the gas controls so that the gas is closed down or the boiler set to work at a lower temperature.

Circulators

On combined systems of heating and hot water supply an alternative to the use of a separate gas boiler for small hot water requirements is the provision of a gas-fired circulator. A circulator is really only a very small gas boiler which may be connected with primary flow and return pipes to the cylinder in the same way as a boiler.

Gas circulators have heating capacities of 14,000 to 20,000 B.Th.U. per hour and are fitted with thermostatic control which allows full use to be made of any heat provided by the main boiler. With such circulators fixing charges are comparatively small as no flues are required and they may be used in conjunction with small domestic boilers or back boilers to ensure adequate hot water all the year round.

The water heater display in the Gas Pavilion at the Ideal Home Exhibition, Olympia, ingeniously arranged on the stockade, which forms part of the "Treasure Island" tableaux, the main feature of this year's exhibit

Many gas authorities have a special gas rate for gas boilers and circulators but even so it is essential that all primary and secondary pipework is insulated to keep down the fuel costs.

To ensure satisfactory water circulation, gas circulators must be fixed some 3 to 4 ft. below the storage tank or cylinder depending upon the primary pipe sizes and resistance through the heating element.

For small hot water supply systems

with storage capacities up to say 30 gallons the circulators may be used as the sole means of water heating. In conjunction with other appliances they may be used with much larger cylinders.

Storage Heaters

Individual storage heaters which are really compact storage systems are supplied in two forms, classified as pressure or non-pressure types. The non-pressure type such as the "Newlyn" heater by Radiation Ltd. has a storage capacity of 5 gallons which can be heated to 100° F. in about one hour. This size of heater may be provided to serve either one draw off point or two or three points; it acts as its own storage tank and must be fitted above the level of the outlets. The passage of the water entering through the automatic water control valve is adjusted and the water is syphoned so that almost the full capacity of hot water may be drawn off at once if desired.

The "Newlyn" non-pressure type of heater is only suitable for providing supplies to sinks, basins, etc., but for larger requirements a pressure-storage heater such as the "Equator" may be used. This heater is manufactured in three sizes with storage capacities of 12, 18 and 25 gallons and recovery periods of 45, 70 and 50 minutes respectively. The "Equator" heater is suitable for a tank water pressure of 50 ft. and may therefore be located in any convenient position and connected with a secondary circulation to serve baths, sinks and basins as if it were an ordinary storage cylinder.

The gas supplies to all storage units are of course thermostatically controlled and their main advantage apart from initial costs is economy in "maintenance" gas consumption due to reduced heat losses during off-peak periods.

A smaller type of heater, having a storage of 1½ gallons is marketed by Ascot Gas Water Heaters Ltd. to provide hot water supplies for such purposes as hairdressing, shaving, etc.

Thomas Potterton Ltd. fabricate complete apparatus containing gas boilers, insulated storage cylinders and all necessary pipework and controls. Such "Storage Sets" are available with storage capacities of from 15 to 200 gallons with recovery periods of approximately one hour.

Instantaneous Heaters

Where no central source of hot water supply is provided or where an alternative supply is needed in summer the instantaneous water heater has great advantages. Especially today when hot water facilities are considered essential and where space is limited is the instantaneous heater most useful.

Instantaneous heaters may be considered in two main classes, either the single or multipoint type. The multipoint heater is suitable for connection to a bath in addition to a sink and basin, or a range of sinks or basins, whilst the single-point heater is suitable for serving one position only.

General

The general principles of pipe sizing for water supplies as explained in previous instalments are applicable to pipes for gas-fired appliances. Details of gas services are outside the scope of this series but in general all necessary particulars are furnished by the manufacturers of gas authority.

Certain water supply authorities have a number of regulations in regard to gas water heaters connected direct from the main supplies. These include stipulations in regard to the water storage capacity of the heater notification of the intention to install such a heater, and isolation from tank water supplies. Most appliances now manufactured comply with other stipulations but it is essential that a stop-valve is fitted to the cold water pipe supplying the heater and a gas cock on the gas connection is also advisable.

(With acknowledgments to "Cheap Steam," November, 1949.)

GAS TURBINE PERFORMANCE

THE first central station gas turbine plant to be installed in the United States has been put into service at Oklahoma, and the latest report shows that it has exceeded its design capacity of 3,500 kw. by approximately 14 per cent. during short periods in four months' operation.

The gas turbine is of the simple open cycle type, fired with natural gas, while the waste heat from the exhaust is used to supplement the feed water heating system of an adjacent steam plant.

Radiant Heat for Core Drying

THIS article is concerned with some experimental work which has been done on the drying of foundry cores. Before proceeding to discuss this work, however, it should be made clear that the use of the word "drying" in this connection is misleading for, although small quantities of water are driven off in some cores, strength, certainly where raw linseed oil is used as the bonding agent, relies upon oxidation. The process should therefore, really be regarded as a curing process.

Mechanism of the Heating Process

Since most standard cores are cured satisfactorily in convection ovens, either forced or natural, what is the object of considering the use of infra-red plant as a substitute? The only possible reason must be the reduction of time, allowing production-line methods to be used in the core shop, and, possibly reducing the amount of space taken up by drying or curing equipment.

The factors which limit the speed of drying of any core are:— (a) the time required for the grains at the centre of the core to reach the curing temperature, and (b) the time required for "setting" to take place once curing temperature has been reached.

The time of factor (a) can be reduced by using large temperature differences in order to promote high heat transfer to the outside of the core and this is the reason why infra-red panels are being considered. The temperature required at the centre of the core can only be obtained by conduction from the heated outer layer. Once the outer skin of the core has reached a temperature beyond which burning will take place, the maximum heating up rate for the inside of the core will have been achieved.

Concerning factor (b), i.e. the time for curing to take place once temperature has been achieved, this will vary with the bonding agent used. In the core bonded by raw linseed oil it would probably be a maximum, while in a core bonded with a high proportion of molasses the effect will more nearly approach that of a polymerising agent. It has been shown that, using raw linseed oil as a binder and curing in a forced convection oven, the greatest tensile strength is obtained in about 1¼ hours with an oven temperature of 375° F. and that this tensile strength is unaltered if the cores are left at this temperature for an hour longer. However, in an oven at 420° F. the highest tensile strength is reached after 45 minutes, and this strength deteriorates at once if the temperature of the core is maintained.

Fig. 1 shows approximately the variations in tensile strength of a core having a bonding agent containing a high proportion of linseed oil at different temperatures. At a temperature of 375° F. maximum strength is attained in about 1¼ hours which strength is maintained for a further 1¼ hours before depreciation is noticed. At a temperature of 410° F. maximum strength is attained in about 1 hour,

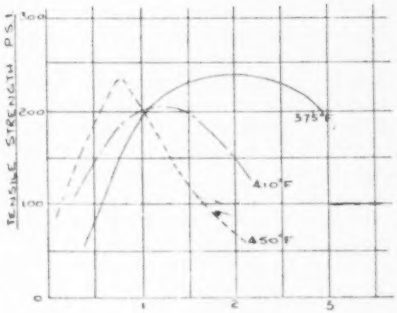


Fig. 1. Approximate variations in tensile strength

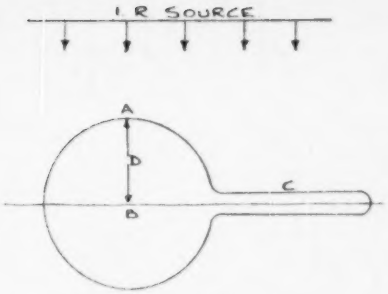


Fig. 2. Cross-section of core

but if the temperature is maintained the tensile strength deteriorates; this effect is very pronounced at a temperature of 450° F.

Fig. 2 represents the cross-section of a core having a heavy circular cross-section with a light section fin attached. The object is to bake the grains at the centre of the core (B) at a temperature of, say, 375° F. If infra-red radiation is used with the object of obtaining a high heat input it is possible, by irradiating the surface (A) of the core, to raise the temperature of this surface quickly to a maximum, beyond which burning will take place. Heat for the grains in the centre of the core must be conducted from this outer surface: therefore it will be appreciated that if the distance (D) between the centre and the outer surface is great, then the tensile strength of the outer surface layers (A) will start to deteriorate before maximum strength is obtained in the centre (B). In the case of the thinner core section (C), this will achieve a temperature higher than the maximum achieved at (A), because it is not losing heat by conduction, and the inference is that the light section will be over-cured and probably burnt.

Having regard to these factors, it would not appear that infra-red methods would have much to commend them, particularly in the case of the heavy-section cores. Several preliminary tests have been made using infra-red equipment without marked success.

Experimental Work

A series of tests was recently carried out with two standard core mixtures as follows:—

	Weight %
(A) Chelford Sand	95
Spermolin Cream ..	5
(B) Chelford Sand	76
Mansfield Sand	19
Spermolin Cream ..	2
Spermolin Semi-Solid ..	3

A number of standard tensile and permeability test pieces were made up in both mixtures. A set of samples in each mixture was baked in a forced convection oven in accordance with normal practice, the time being 75 minutes and the temperature 356° F. The other cores from the same mix were baked in a standard G.L.C. gas-fired infra-red tunnel of 24 in. diameter. Two radiating temperatures were used 600° F. and 700° F. with variable times in each case.

Mix A cores baked more slowly than Mix B, and this was due to greater reflection from the light coloured sand than from the red Mansfield sand. Tensile and permeability test figures were obtained in all cases and are recorded in Tables 1 and 2.

Methods of Test

Permeability

The standard tests for foundry sands as used by the foundry industry in this country are those laid down by the American Foundrymen's Association, and are briefly as follows:—

Permeability is defined for the purpose of these tests as "the volume of air, in c.c., that will pass, per minute, under a pressure of 1 gram per sq. cm. through a specimen 1 sq. cm. in

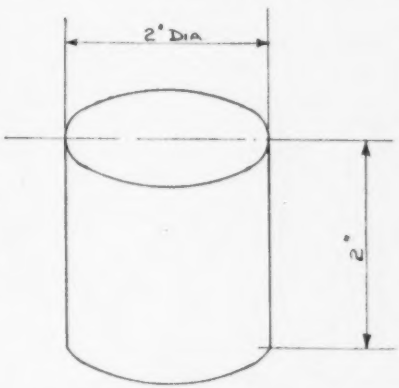


Fig. 3. Standard test specimen for permeability

cross-sectional area and 1 cm. high," and the following general formula may be used:—

$$P = \frac{V.h.}{p.a.t.}$$

where P = permeability number
V = volume of air passed through specimen ... c.c.
h = height of specimen ... ... cm.
p = pressure of air ... ... g/sq.cm.
a = cross-sectional area of specimen ... ... s/q.cm.
t = time ... ... min.

In practice, a standard specimen 2 in. high × 2 in. overall diameter (see Fig. 3) is made with a standard apparatus giving three ramming blows of pre-determined weight and drop. This specimen is used in a standard permeability testing outfit which can be compared to the specimen being placed in the outlet of a small gas-holder floating in water. The apparatus is arranged so that the pressure difference across the specimen may be directly read off in gram per sq. cm. It is usual practice to pass 2,000 c.c. of air through the standard specimen at a pressure of 10 grams per sq. cm. Under these standard conditions of test the formula quoted above becomes:— $P = \frac{501{\cdot}2}{\text{pressure in g/sq. cm.} \times \text{time in min.}}$

Tensile Strength

The tensile strength is determined on a standard specimen as shown in Fig. 4, which, it will be seen, has a minimum cross-sectional area of 1 sq. in. A special tensile pulling machine is used from which the breaking point of the specimen may be read directly in p.s.i.

Conclusions and Recommendations

The results of the tests shown in Tables 1 and 2 can be summarised as follows:—

1. Small cores of uniform cross-section and not exceeding 1 in. maximum thickness can be cured to achieve a good tensile strength in 14 minutes, compared with 75 minutes by forced convection methods.
2. For thicknesses greater than 1 in., low permeability indicated insufficient curing within the core.
3. Lower temperatures, reducing heat transfer, can to some extent, overcome this trouble, but the time of curing increases very greatly, and is of the order of 36 minutes, using a radiating temperature of 600° F.
4. The effect of large differences in cross-section of a core is to make

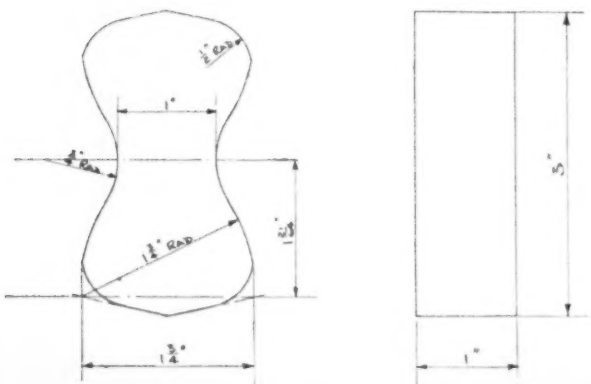


Fig. 4
Standard test specimen for tensile strength

TABLE 1

MIX TYPE C2 Comprising Chelford Sand 95%
Spermolin Cream 5%

Test No.	*Plant*	*Temp. °F.*	*Time min.*	*Strength Tensile p.s.i.*	*Permeability No.*	*Observations*
1	Forced convection core stove	356	75	174	270	In accordance with standard practice
2	G.L.C. type infra-red tunnel gas-fired, 24 in. diameter	Average panel 700	15	148	250	Core kept too near open end of oven and unevenly irradiated
3	ditto	ditto	18	158	255	Slightly burned at edges. Tensile test piece slightly over-size
4	ditto	ditto	14	175	250	Low permeability, indicative of insufficient curing in centre
5	ditto	Average panel 600	15¼	88	230	Insufficient time allowed
6	ditto	ditto	26	163	250	
7	ditto	ditto	36	177	—	More time would still improve result

impossible the satisfactory drying by infra-red.

5. The effect of shadow of one core upon another is very marked, and shadow effect must be eliminated.

It must be concluded from the above that under conditions met with in normal foundry practice today, infra-red methods of core drying are not to be recommended. Any advantage which may be gained by curing a limited range of cores quickly is offset

TABLE 2

MIX TYPE C6 Comprising Chelford Sand 76%
Mansfield Sand 19%
Spermolin Cream 2%
Spermolin Semi-Solid 3%

Test No.	*Plant*	*Temp. °F.*	*Time min.*	*Tensile Strength p.s.i.*	*Permeability No.*	*Observations*
8	Forced convection core stove	356	75	219	200	In accordance with standard practice.
9	G.L.C. type infra-red tunnel gas-fired, 24 in. diameter	Average panel 700	15	191	180	Slight surface burning
10	ditto	ditto	12½	155	190	Tensile test specimen $\frac{1}{16}$ in. too thick
11	ditto	ditto	10	93	—	Undercured Soft in centre
12	ditto	Average panel 600	14	95	175	Uncured
13	ditto	ditto	20	133	170	Undercured
14	ditto	ditto	23	165	170	More time might have improved result

by inconsistency and lack of control in the great majority of cases.

It would appear that one answer to the demands for increased speeds of curing of normal types of cores would be a controlled forced convection oven using higher velocities than normal. At a guess, most cores would stand up to velocities of 30 ft. per second, and there is a possibility that, owing to the high permeability of these cores, some air would pass into the centre, thus improving the oxidation effect which is required.

Whether, in years to come, the new synthetic resin core binders may lend themselves more readily to infra-red curing is a matter for investigation. Such new bonding agents, to be suitable for infra-red baking, must cure instantly on reaching temperature and must be able to stand a large margin of overheating without deterioration, though this last characteristic may well be detrimental to the knock-out qualities of the core which are required.

Prepared from a report of the Industrial Gas Committee—East Midlands Gas Board.

Gas as a Fuel in Ceramic Manufacture

Some Striking Figures from Stoke-on-Trent

IN the eleven years since the beginning of the second World War, manufacturers of earthenware and glassware have devoted increasing attention to the choice of controllable and reliable heat services with a view to raising the standard of quality and quantity of their products. Their preference is reflected in the fact that in the last year before nationalisation of the gas industry, the City of Stoke-on-Trent Gas Department sold 60 per cent. of its output for consumption in the ceramic industry, or more than the total sales for all purposes in 1945. Following is an analysis of the industrial consumption in 1949:

	c. ft.
Sanitary ware	231,051,000
Tiles	918,069,600
Earthenware	1,355,683,400
China	229,577,700
Electric porcelain ...	374,262,800
Other industrial purposes	552,200,200
Total	3,660,844,700

These figures showed an increase of over 608 million c. ft., or 19·59 per cent. over the previous year. They indicate the valuable contribution which the gas undertaking has made towards improved methods of firing since the first practical application of town gas in 1932.

From that date until three or four years ago the installation of tunnel kilns proceeded at a steady rate, but more recently there has been a phenomenal rise in the pace of kiln building and in the demand for gas in their operation. Mr. J. E. Stanier, Chief Engineer and General Manager of the Undertaking, reports that the applications for gas for the new kilns exceed the production capacity of the gas-works plant, and the rate at which such applications can be accepted is dependent on the speed at which new manufacturing and ancillary plant can be installed.

New Plant

During 1949 eleven new gas-fired continuous tunnel kilns were brought into operation and an appreciable number are in hand for this year. Two large makers of sanitary fireclay of national repute have introduced continuous gas-fired tunnel kilns in the last few months for firing sanitary ware both in the biscuit and glost states, and the results have been completely satisfactory.

This departure in ceramic firing is likely to be of growing importance in the future as more of this class of ware is fired in continuous kilns. Gas-fired tunnel kilns in operation in the pottery towns at the end of the year totalled 130, plus twenty intermittent kilns, as against sixty-six for the last pre-war year. Concurrently, gas consumption for the ceramic industry has risen from 1,341 million c. ft. in 1939 to the remarkable figure of 3,108 million c. ft. in 1949, an increase of 138 per cent.

The drying of raw clay and of part-finished ware in all sections of ceramic

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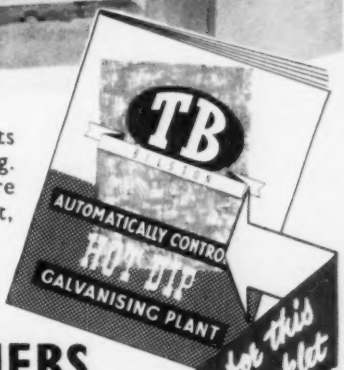

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industry is being increasingly changed over to town gas. The resulting ware is not only improved in quality, but production is expedited, conditions for operatives are cleaner and healthier and the work becomes more genial. A number of installations employing overhead radiant panel heaters were completed last year, providing a most useful heating medium for the majority of factories and workshops. The rapidity with which comfortable conditions are attained is appreciated, and widespread adoption is expected to follow.

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Simplicity, and freedom from gland troubles, associated with the pumping of suspended solids, is another feature, whilst the design renders sealing water unnecessary, with the consequent saving in operating attention and replacements. The need for high-pressure water supply and the undesirable dilution of pulp are obviated.

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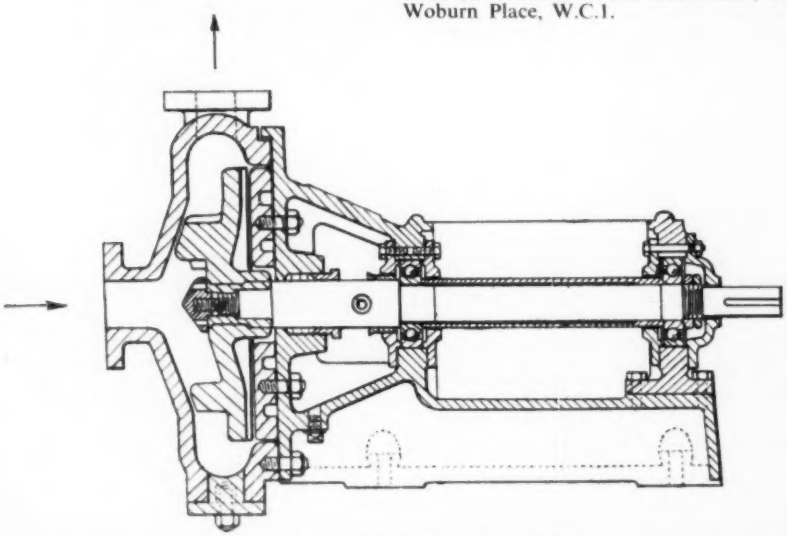
A fully descriptive leaflet is obtainable from International Combustion Ltd., 19 Woburn Place, W.C.1.



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Hot Water Supply for a Self Service Laundry

WHEN an enquiry was received by the Liverpool Undertaking of the North Western Gas Board for a hot water supply to an automatic self service laundry to estimate requirements, the following information was obtained.

The laundry equipment was to consist of ten Bendix washing machines, a hydro extractor of the centrifuge type and two rinsing sinks.

The rinsing sinks are for the washing and rinsing of any articles that would not be washed in the Bendix with the "whites" and "cottons" such as "woollens," "smalls," "nylons," etc.

The laundry was to operate a 1 hour service, the actual washing operation taking 40-45 minutes and the remaining time would be for drying the articles to ironing condition in the hydro extractor and packing them to be carried away.

The following table gives details of operation of the Bendix washing machine.

Operation	*Time min.*	*Hot water required gal.*	*Cold water required gal.*
Soak	15	2	3
Wash	15	5	—
First rinse	2	2	3
Second ,,	5	2	3
Third ,,	5	2	3

The required temperature of the hot water is between 140° and 160° F. and consequently, during the processes requiring a mixture of hot and cold water, the resultant temperature will be between 80° and 90° F.

From this information it can be seen that the required amount of hot water for one washing period is 13 gallons per machine or 130 gallons for the installation. Allowing for the water required at the rinsing sinks it was suggested that a 200 gallon hot water storage cylinder be installed with a boiler rating of 198,000 B.Th.U. per hour. This would give 165 gallon per hour at 120° F. rise.

To ensure that there would be no discoloration of the water, however slight the risk, it was suggested that a calorifier, i.e. an indirect system, be incorporated, also a secondary circulation system to ensure that hot water is always available in close proximity to each machine.

The recommendations, as above, were put forward to the consumer who, requested the gas undertaking to install a 100 gallon storage set with a capacity of 90,000 B.Th.U. per hour, this being provided by three No. 012 Solar boilers each having an output of 29,600 B.Th.U. per hour.

After installation of this equipment, a test was carried out primarily to find out the amount of hot water being used per machine. Seven machines were in operation during the test period and it was found that the average amount of hot water per machine was 15¼ gallons.

The installation supplied water to the seven machines at an average temperature of 144° F. It was obvious that the rate of recovery was insufficient and, at the end of the one hour test period, there was a considerable deficiency in the hot water storage.

Bendix Washing Machine

The appliance, which is made by Bendix Home Appliances Ltd., 99a Park Lane, London, W.1. consists essentially of two concentric drums. The inner one, into which the articles are loaded, is perforated and is capable of revolving at two speeds. The outer drum is the water container.

Hot and cold water are admitted to this outer drum through two solenoid operated valves which, together with the electric motor, are controlled by a time switch.

For the operations "soak," "2nd rinse" and "3rd rinse," both valves open allowing hot and cold water to enter, the resultant temperature being about 90° F. This mixture temperature depends on the temperature of the hot water as there is no thermostatic control of mixing. The hot and cold water are mixed proportionately by

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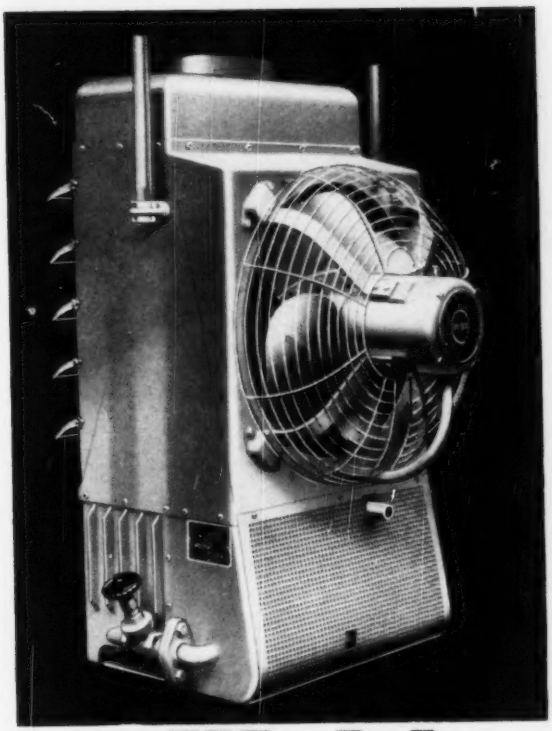

The heating element is made from stainless steel to ensure long life.

They are fitted with automatic control cut outs to render them safe in the event of failure in gas or electrical supplies.

Operation of these units during the normal working period can be simply effected by switching on and off the electrical supply and, therefore, can be satisfactorily controlled by a standard thermostat if required.

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A typical self service laundry installation

fixed rates of flow. When a predetermined level is reached, a float switch operates the solenoid valves and the water supply is cut off.

During a normal "wash" period, only the hot water valve opens, thus allowing water to enter at 140°-160° F. If woollens are to be washed, this high temperature is not required and by moving a switch marked "hot" and "warm" to the "warm" position, both the hot and cold valves open allowing a mixture to enter, as in the other operations.

During the "1st rinse," the mixture of hot and cold water passes straight through the drum carrying with it the dislodged dirt. Hence, in this operation, the drum does not fill and so the float switch does not operate. The water supply is cut off in this case by the time switch. It is in this operation that discrepancies in the amount of water being used can occur.

The rate of flow of cold water into the drum is constant at about 2 gallons per minute. In winter, therefore, when the temperature of the cold

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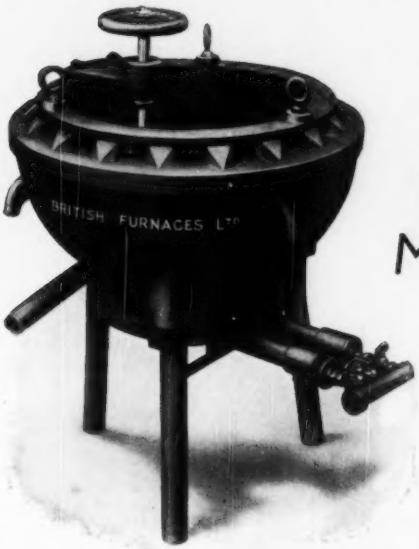

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water is lower, the rate of flow of the hot water must be increased to maintain the required temperature in the machine. This is done by the Summer/Winter control, a throttle in the hot water inlet.

On completion of the washing operation, the internal drum spins at a high speed to remove water from the articles and leaves them ready for final drying.

Waste water, after each operation, is removed from the machine by a pump and a drain valve.

Hydro Extractor

In this particular installation, the articles are placed in a self balancing hydro extractor. This removes more water from them and leaves them ready for ironing.

The hydro extractor of the centrifugal type, made by Broadbent, Huddersfield, consists of an inner circular perforated drum that rotates in a horizontal plane inside an outer casing. The clothes from the Bendix machines are placed into marked laundry bags (string type). These bags are then placed around the circumference of the inner drum. The lid is then closed and the motor started. The electric motor switch is inter-connected with the fastening handle of the lid so as to ensure that the lid is secure before the motor is started. Incorporated is an adjustable time switch and the period of spin can be varied from 3 minutes to 15 minutes.

The "hydro" installed will take eight bags of washing equivalent to 72 lb. of dry clothes. The drying operation takes 4 minutes; this includes 1¼ minutes to reach the maximum speed of 1,450 r.p.m. and ¾ minute to slow down.

A test was carried out to find how much more water could be extracted from the clothes after they had been spun in the Bendix machine. The following are the results:—

	Weight lb.	*% of weight of dry clothes*
Before treatment		
Clothes plus bag	10	
Bag	1	
Clothes, by difference	9	
Washed and spun in Bendix machine		
Clothes plus bag	18½	
Water in clothes, by difference	8½	94½
Spun for 4 min. in hydro-extractor		
Clothes plus bag	13½	
Water in clothes, by difference	3½	36
Spun for further 4 min. in hydro-extractor		
Clothes plus bag	13⅜	
Water in clothes, by difference	3⅜	34½

It would appear from this that on a commercial basis the first four minutes run was quite sufficient.

The above figures suggest that the clothes are dried to "ironing conditions." From available information it appears that, if the water content is between 25 per cent. and 35 per cent., "ironing conditions" have been reached.

It appears from the test that, provided the washing operation takes place once every hour, each machine will require a storage capacity of 16 gallons. This quantity when raised 110° F. requires a boiler output of 17,600 B.Th.U. To allow for various losses a figure of 22,000 B.Th.U. is proposed.

Prepared from a report of the Industrial Gas Committee—North-Western Gas Board.

EXPERIMENTAL GAS TURBINE GENERATOR

SOME further information on the experimental gas turbine electricity generator to be installed at Coventry gasworks has been obtained. The cost is estimated at £70,000, and the machine's performance will be closely watched by the Area Electricity Board, who are hopeful that it will provide an economical means of increasing the electricity supply for that quarter. The new plant's chief purpose is of course to generate current for use at the works, and will be operated entirely by waste heat. It is still in the blueprint stage, and will be constructed by John Brown Ltd., the Clydeside shipbuilding firm, who anticipate that it will be completed in 1952.

Mr. A. Allen, divisional manager under the Gas Board for Warwickshire, said that if the experiment was successful these gas turbines might be built at all major gasworks. The turbine would be driven by the hot waste gases arising from the coal-gas producing process in standard type retorts, which gases are at present piped from the retorts into gasworks boilers.

Known as the 700 kilowatt closed cycle turbine, it is said to require only a percentage of the waste gases emitted from the retorts; the remainder will continue to serve boilers for steam production. The running speed of the generator is 9,800 revolutions per minute.

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Ceramic Industry Links Progress to Gas

The Story of Industrial Gas in Trenton, U.S.A.

HAND-FORMED bricks of clay-bearing mud and straw were baked in the sun until early experimenters found that bricks baked in red hot ashes for several hours became rock-hard and insoluble. This process was then used to make durable pottery.

In searching for a material that could be moulded, carved or cast then treated to form a solid hard product, clay was found to be the ideal medium. This material is easily obtained because three-fourths of the earth's crust is composed of clay-forming materials, oxygen, silicon, and aluminium. The ever increasing supply of hydrated aluminium silicate, or clay, is due to the natural weathering of rocks.

These early objects were porous until it was discovered that a newly developed substance, glass, could be applied to the surface to give a better finish and also make them impervious to liquids. It was also discovered that colour could be applied, and this led to decorative designs. Thus the ceramic industry had its beginnings.

A decade ago in Trenton gas fuel in the ceramic industry was something of a myth, something *de luxe*, and far beyond the economic reach of the commercial pottery. Through the efforts of industrial gas engineers and forward looking potters who had faith in the so-called "new" fuel, new techniques were developed which resulted in convincing proof that gas was the ideal fuel for ceramic firing.

No article on industrial gas in Trenton could be written were it not for Lenox, Inc., producer of America's finest china, figurines, and objects of art. It has been a pioneer in fostering improvements in manufacturing techniques that were eventually to

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become accepted practices throughout the pottery industry.

Pottery of Today

At the Lenox pottery they are carrying on the tradition of Walter Scott Lenox, founder, whose only aim was perfection.

The high standards established by the founder have been scrupulously adhered to over the years. To keep pace with demand for Lenox products, changes have been made from time to time in production facilities. With each new development in ceramic processing, Lenox has adopted the best and has worked that process into its production lines. Modernisation has been done in such a manner that nothing of the artistry has been lost. In most instances the artistry actually has been improved in making a better product. The major change that has been made in recent years has been in the firing of bisque, glost, and decoration.

Pioneering

It was at Lenox that the pioneering on gas-fired kilns was done in co-operation with gas engineers, kiln and burner manufacturers, and Lenox' own ceramic experts. Experiment after experiment was conducted, and all fuels were given impartial tests. Various types of kilns were built, some for direct firing, some with muffles, and others for radiant firing. In fact, every possible method was employed to attain the goal of a continuous method of firing with the best available fuel. Gas fuel met all the requirements, because it could be most easily and accurately controlled; there was uniform heat distribution throughout the kiln section; and the heat could be zoned along the length of the kiln.

These tests went on over a period of many years. Various types of burners and gas-air mixtures were also used during the experiments until satisfactory results were obtained. Production was kept up during this time, and at present it is felt that the firing operations have reached their peak of efficiency.

The present kilns in use are varied, but each is designed for specific purposes. One of the large production kilns is of the continuous circular type, 80 ft. in diameter and direct fired in the hot zones by means of radiant cup burners utilising pre-mixed gas. There is also another circular kiln 90 ft. in diameter which is a continuous muffle type fired by low pressure inspirator burners. All the other kilns are of the through type. One for both bisque and glost is a 60 ft., semi-muffle, walking beam kiln fired by pre-mixed gas. Another is a twin tunnel, 58 ft. long fired by low pressure inspirator burners for glost and decorating firing. One kiln used for decorating only is a continuous radiant tube type on pre-mixed gas.

Also there is a kiln that was designed primarily for experimental work but is being utilised for production. It is being fired in a unique manner by radiant cup burners which have offset carborundum plates in front of them acting as a sort of muffle. The entire furnace is under a minus atmosphere so that the products of combustion do not come in contact with the work.

Universal Fuel

Gas fuel has proven so satisfactory that it has been selected as the fuel for all main firing operations. That gas is rapidly becoming the universal fuel for this industry in Trenton is the result of the years of ground work and research done by Lenox for the ultimate benefit of the ceramic industry. The principal advantages are a better product is obtained through accurately controlled heat, production costs can be lowered, and the number of rejects materially reduced.

One of the first potteries to take advantage of gas fuel after its initial adoption was the Stangl Pottery. Only a little over 10 years has passed since the gas-fired continuous kiln was installed by John Martin Stangl. After much investigation, he consented to install a gas-fired continuous automatically controlled kiln. The industrial gas engineers succeeded in every way in making this kiln live up to their expectations.

The Stangl Pottery manufactures a line of dinnerware, but this part of the story only treats on its beautifully coloured china birds, and it is the only complete line of china birds in the country. These birds are beautiful to behold, done in all their

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natural colours. The birds are first cast and bisque fired in a 116 ft. continuous gas-fired kiln under automatic temperature control for three hours at 2,100° F.

A unique part of this operation, and one which speeds up production, is that the waste flue gases, after being utilised for preheating at the beginning of the kiln, are conducted to a separate continuous drying oven to dry the bisque thoroughly before it goes into the kiln for firing. By removing every bit of moisture before firing, a much better bisque object is obtained, and spoilage is kept at a minimum: The birds are then hand coloured by highly skilled operators, the glaze applied, then fired for 18 hours at 2,000° F. in the 95 ft. continuous glost kiln.

Reduced Rejects

Before the universal use of gas for ceramic firing, rejects in glazed ware often amounted to over 45 per cent. of total production. This of course was economically unsound. With the advent of gas and efficient kiln construction, rejects have been reduced to 4 per cent. and 6 per cent. and in some instances to zero. Several innovations were installed in Trenton potteries; never before had direct firing been done on "glost ware" and on "once fired" ware. It was the courage of the gas engineers and manufacturers of ceramic kilns who knew the job could be done with this modern fuel that led to its adoption.

The adoption of gas fuel has almost as many reasons as there are potteries availing themselves of it. Over-all, the economics of gas was the deciding factor. A few of the reasons are cited here.

One pottery had traditional "beehive" kilns. Only a slight knowledge of the industry need be had to know the days that are spent in loading such a kiln, the time spent in bringing it up to heat, the firing cycle, then the cooling off period before unloading.

In many instances the entire operation for one batch in this type of kiln took six or seven days; then a continuous gas-fired kiln was installed, reducing the entire cycle, from first forming to packing for shipment, to 32 hours. With such a reduction in processing time which so materially increased the production rate, the cost of the new kiln and the cost of gas was a lesser consideration.

In another instance a continuous kiln was converted to gas, and the cost of gas exactly equalled the saving in labour. Other benefits were increased production and better products.

The continuous gas-fired kiln has been a major factor in the reduction of rejects, accounted for, in part, to less handling of the ware by operators which has practically eliminated breakage, and the uniformity of firing by even heat distribution and precision automatic temperature control. When the end results are analysed, the increased production, uniformity and better product obtained, gas has proven to be the ideal fuel for this purpose. While the cost of gas must be considered, it has been found, in many cases, to be most economical in addition to the other factors involved.

Variety of Products

To illustrate a variety of ceramic products, the operations of several potteries will be described. Industrial ceramics form a large part of this business, and one of the leaders in this field is the Mitchell-Bissell Co., manufacturer of porcelain thread guides for textile machinery. The use of porcelain for thread guides was originated by the founder of this business. First guides were made in 1877, and thread guides, as such, are now used all over the world.

Its present plant was built in 1920 and the changeover from beehive kilns, using another fuel, to the present continuous gas-fired tunnel kiln was made in 1946. This new kiln reduced the processing cycle from a week to 32 hours, and the kiln has only been shut down twice since it was first started, and then only for inspection purposes.

Over the 60 years this company has been in business, some 3,000 designs of textile porcelains have been made. These items range in size from $\frac{1}{4}$ in. to 8 in., and all are processed in the same manner. They are formed from a clay mixture in mechanical presses, hand dipped in glaze, then fired. The new kiln is the most modern that can be obtained, direct firing with burners using

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pre-mixed gas. It is 87 ft. long, and the load on the 60 in. cars is 18 in. wide by 24 in. high. The firing cycle is 32 hours at 2,500° F. high heat.

Circulation of the products of combustion is used to preheat the ware on entering the kiln. Automatic temperature control throughout and uniform heat distribution result in even firing at all points of the cars. This efficient construction of the kiln is one reason that car after car comes out of the kiln in such perfect condition that there are no rejects. In this particular plant, rejects are limited to those items which become damaged in handling before or after the firing. This installation is one of the finest examples of direct firing of glost ware.

One phase of dinnerware manufacture is that of supplying hotels and restaurants. One of the largest organisations making this type of ware, and one that is known the world over, is the Scammel China Co. Here at its plant the bisque kiln has recently been converted to gas, with substantial savings in labour costs and an improved product. Just another in the long chain of potteries availing themselves of this modern efficient fuel.

One of the most interesting ceramic operations is that at Cordey China Co. which produces a line of figurines.

Cordey China Co. was founded in July, 1942, and has recently moved into its large new plant on Enterprise Ave. In its new plant, occupying four acres of ground, are to be found the newest and best developments in the making of china. Constructed largely of glass and white plaster walls being air conditioned in most departments, the plant affords the greatest amount of natural light possible, a factor of vital importance to skilled craftsmen engaged in delicate operations.

Manufacturing Process

The essential ingredients of china are only ordinary products of mines and fields, being clay, feldspar, flint, and whiting. These materials are mixed carefully according to Cordey formulæ, which are strictly adhered to, to insure the fineness of texture and uniformity of body.

After this careful process, the materials become a fluid called slip. The slip is aged properly until it is ready to be used for casting, or the making of the china. Casting is a process requiring skilled workmanship. The slip is poured into moulds, made of plaster of paris which absorbs the water in the slip, thus as it dries, it adheres to the side of the mould forming the body of the piece of ware. When the slip is the right thickness, the excess is poured out, leaving the delicate piece of china formed in the mould. This is allowed to dry to the right consistency, and then the casted shape is removed from the mould.

The shape is then transported to the mounting department where the trimmings are mounted and affixed by hand. The mounting of the figurines requires artistic ability of a high degree. Those familiar with the affixing of the hand moulded trimmings can well realise the care that must be taken to perform this operation. The china is in the "green" or unbaked state, and any pressure will throw it out of shape.

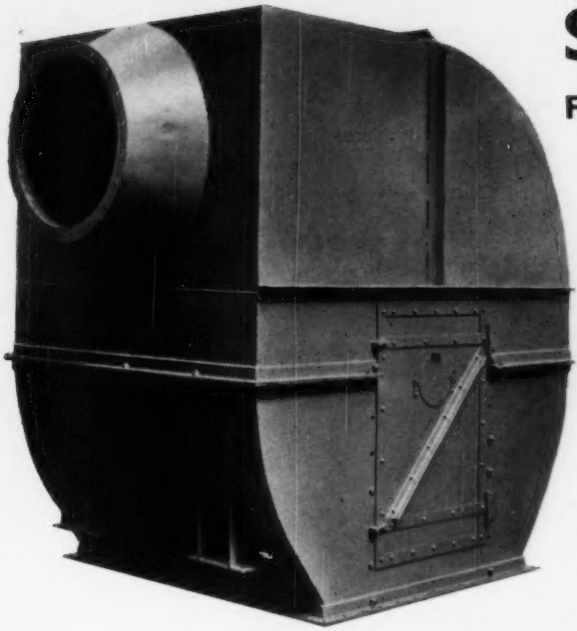
Finishing

When the shapes have been completed they are thoroughly dried, after which they are taken to the finishing department where the mould marks and any roughness are removed by sponge and water. Great care is exercised at this stage as any imperfection will show on the finished piece unless properly cleaned by the finishers. The piece is then dipped in transparent glaze, a substance when baked at a high degree of temperature, fuses and covers the body with a smooth, transparent coating.

The pieces are then placed in a large continuous kiln and "fired" at a temperature of 2,100° F. When they emerge from the kiln, the shapes are ready to have the decorations applied by hand. All the gold work is also applied free hand by the artists. When the object is finished, it is fired again in the decorating kiln to bake the gold and colour in the china body.

Art Pottery

It is in order to mention one other segment of the ceramic industry, that of art goods, such as lamp bases as manufactured by the General Porcelain Manufacturing Co. This company has a continuous gas-fired tunnel



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kiln for its single fire ware. The various items made are cast from slip in the conventional manner, glaze applied, in white and colours, both of which are direct fired.

The kiln is 110 ft. long and the car area is 60 in. long, 30 in. wide, and 32 in. high. The ware is preheated by flue gases and all air for combustion is taken from the preheat zone at approximately 400° F. The 4 inspirator burners are supplied with a gas-air mixture and 6 in. w.c. gas. Each burner has individual control to maintain exact temperature settings for the high heat of 2,150° to 2,200° F. of a 24 hour cycle. The direct firing of both white and coloured glazes has been most successful in this plant. With the gas-fired kiln and the precision automatic control of temperature a much better product has been obtained and rejects are at an acceptable minimum.

Throughout the entire ceramic industry in Trenton, gas fuel has been proved to be the ideal fuel for bisque and glost firing as well as single fired ware.

"Industrial Gas," U.S.A., January, 1950.

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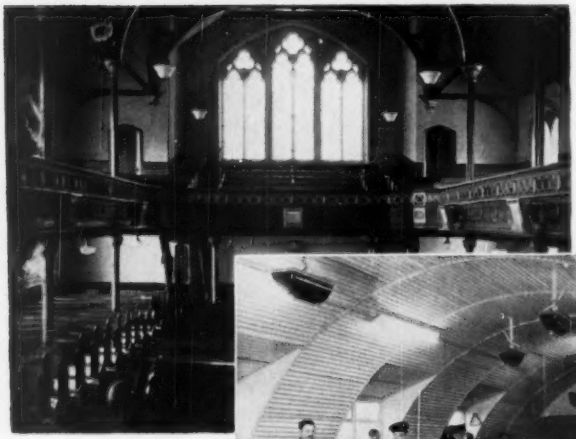

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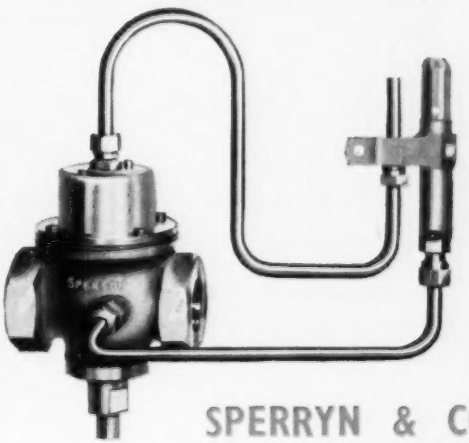

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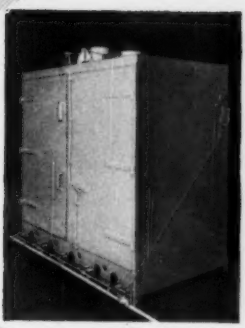

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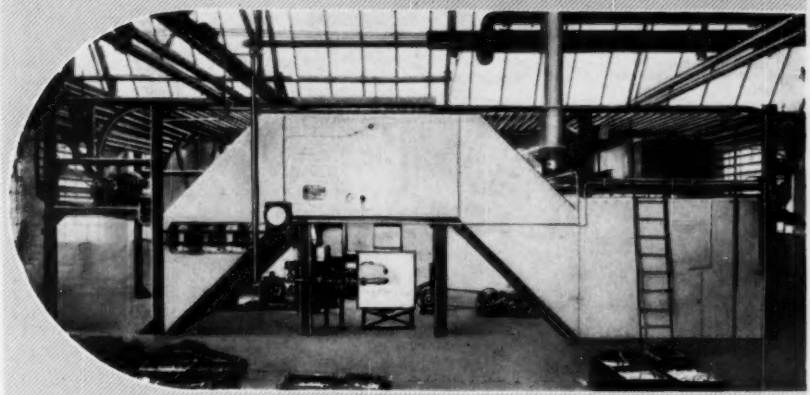

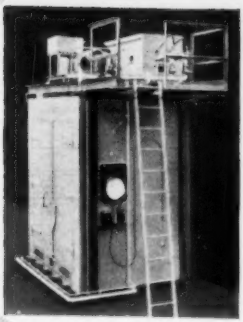

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